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P.Q. 12,805

2. Patent application number
(The

9903126.2

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3. Full [redacted] and postcode of the or of each applicant *(underline all surnames)*

Central Research Laboratories Limited
Dawley Road
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Middlesex
UB3 1HH

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

England

6097943001

4. Title of the invention

APPARATUS FOR, AND METHOD OF, ENCODING INFORMATION INTO, AND DECODING INFORMATION FROM, A SEQUENCE OF MOVING IMAGES

5. Name of your agent *(if you have one)*

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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Continuation sheets of this form	
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Claim(s)	2
Abstract	1
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Request for preliminary examination and search *(Patents Form 9/77)*	1
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Neville Walker, 0181 848 6692

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APPARATUS FOR, AND METHOD OF, ENCODING INFORMATION INTO, AND DECODING INFORMATION FROM, A SEQUENCE OF MOVING IMAGES

The present invention relates to an apparatus for, and method of, encoding information into and decoding information from a sequence of moving images. The technique of coding information into a sequence of video or cinematographic images is also known as electronic watermarking. The invention is therefore particularly, but not exclusively, suitable for electronic watermarking all types of media having moving images stored thereon.

It is known to insert codes into images for the purpose of identifying the owner of the images. The images may be in the form of video transmissions, or video clips or stills transmitted across a telecommunication link. There are a number of known schemes for inserting identification codes into so called 'sync' periods in transmitted video images. More recently it has been proposed to insert identification codes into the image itself in such a way that the code cannot be detected by a human eye. Such schemes may suffer from the disadvantage that low pass filtering and other image processes, such as data compression, may remove the code or degrade it to an extent that it cannot be recognised.

In video broadcasting, data can be in either digital or analogue form. Increasingly data is transmitted in digital form. One reason for this is because larger amounts of data can be transmitted in digital form than in analogue form. Another is because digital signals are less prone to interference and can easily be recovered by using error correction techniques if received images are distorted. However, as side effects of facile access to digital data, complaints of copyright infringement and for tampering or modification of content are increasing.

All current schemes suffer from the disadvantage that coded digital information cannot easily be transformed and maintain its integrity. Low pass filtering and other processes, such as data compression, may occur as a result of image compression algorithms or transmission of audio signals across a telecommunication link. Such transforms may remove the code or degrade it to an extent where it cannot be recognised.

In the Applicant's published International Patent Application WO-A1-9625005 (Todd), there is described a method of coding data into an image. The method of coding and decoding information into an image, comprises: dividing the image into MxN blocks, selectively encoding (decoding) information into selected blocks in such a way as not to be visible to a human eye, wherein in a decoding stage, the decoding is synchronised to the occurrence of the blocks for analysis of image information. In a preferred embodiment the size of insertions and their positions are fixed by processing the image in a block-by-block manner, typically with a block size of 8 by 8 pixels.

In MPEG compression standards, temporal redundancy in image sequences is reduced by block-based motion compensation. Any change in an image from its previous frame caused by object movement is reserved to recover the image in the process of image decompression. Whilst previous encoding techniques have been successful, sometimes embedded codes have not survived MPEG compression.

The present invention arose to overcome this problem.

According to a first aspect of the present invention there is provided an apparatus for encoding information into a moving image sequence, comprising: means for identifying a region in an image in the sequence, means for determining whether the said region is a moving or static region and means for inserting a code into at least said moving image region.

According to a second aspect of the present invention there is provided a method of encoding information into a sequence of images; the sequence of images comprising: a first image and a subsequent image, the method comprising the steps of: locating an edge in the first image, locating a corresponding edge in the subsequent image, comparing relative positions of the corresponding edges in said first and second images, thereby identifying either a relatively static edge or two relatively moving edges; inserting a first code into said moving edge and inserting a second code into said static edge.

The invention thus solves the problem of preserving both static and moving encoded information during subsequent image compression.

Preferably the apparatus and method identify moving, and therefore static edges, in an image sequence and treat moving and static edges as separate channels each carrying its own code(s). Hence identification information is encoded into both moving edges (which are not compressed to any extent) and static edges independently. Both channels may carry identical codes if required. Alternatively different codes may be inserted into moving or static edges. The code insertion technique of the present invention may be used to embed codes in moving edge pixels.

Means is advantageously provided to preselect said relative moving edges so that a code can be inserted into switchable sequences. If there is no movement in a sequence of images, no code is inserted and a different sequence may be selected.

According to another aspect of the present invention there is provided apparatus for decoding information from an encoded moving image sequence, comprising: means for identifying a region in an image in the sequence, means for determining whether the said region is a moving or static region and means for recovering code from at least said moving image region.

Corresponding to this further aspect of the invention, there is also provided a method of decoding information from an encoded moving image sequence.

Preferably coded information is inserted into an image in so called strongly featured regions of an image in such a way that the code is resistant to image compression and/or low pass filtering, but is not visible to the human eye. Examples of strongly featured regions of images are textured regions or lines, or edges between two regions of different luminance or contrast. In such regions, it is possible to insert a relatively large amount of information without significantly altering the image.

Information encoded into an image may be used for a variety of purposes, for example:

i) to insert copyright or identification information into video clips or still images;

ii) to monitor when advertisements or films are played in broadcasts, for monitoring royalty payment purposes;

iii) to identify a master copy of a data storage medium, such as a CD or DVD or video disc or similar medium, from which pirated copies may be produced.

Codes are preferably inserted in edges within an image. Edge regions are known to have masking properties because of the way the human visual system works. In particular, the local orientation of edges are important, and there are specific structures in the primary visual cortex of the human brain, for detecting the presence of an edge and its local orientation.

Coded information is preferably inserted into an image so that it does not alter the local orientation of certain features. The insertions are preferably made along the length of a local section of edge. The insertions are preferably made as a 2D function, by using for example an ellipse which is aligned to the local orientation of the edge.

There is correspondingly also provided a method of encoding information into, and decoding information from, a moving image sequence, having one or more of the aforementioned preferred features.

An embodiment of the invention will now be described, by way of example only, with reference to the Figures, in which:-

Figure 1 shows diagrammatically an embodiment of an encoder according to the invention;

Figure 2 shows an embodiment of a decoder according to the invention;

Figure 3 shows a sketch with edges of images in bold; and

Figure 4 shows the sketch of Figure 3, with only moving edges highlighted in bold.

Referring to the Figures, Figures 1 and 2 show block diagrams of an encoder 10 and decoder 20 respectively. The invention will now be described in the encoding sequence with reference to Figure 1. The signal is split into two portions: a moving image signal 22 and a static image signal 23. This can be according to a standard MPEG protocol or a different proprietary image analysis (compression) protocol.

A first code is inserted into the static image signal and a second code is inserted into the moving image signal. These signals are then transmitted in separate channels.

The moving edge encoding sequence is now described with reference to the following Equations 1 to 3 and Figures 3 and 4.

Moving edges and static edges may be defined as the following:

Let $I_1(x,y)$, $I_2(x,y)$, and $I_3(x,y)$ denote three consecutive images in an image sequence. Let $E_2(x,y)$ be an edge image from image $I_2(x,y)$. The moving edge image $ME(x,y)$ is defined as follows:

$$ME(x,y) = D_{12}(x,y) \cdot E_2(x,y) \cdot D_{23}(x,y) \text{ - (Eqn 1)}$$

where $D_{12}(x,y) = |I_1(x,y) - I_2(x,y)|$, $D_{23}(x,y) = |I_2(x,y) - I_3(x,y)|$. - (Eqn 2)

The static edge image $SE(x,y)$ may be obtained using the following equation:

$$SE(x,y) = E2(x,y) \text{ if } ME(x,y) = 0 \text{ - (Eqn 3)}$$

Once inserted the coded information is treated the same as a moving image by any compression algorithm or protocol such as MPEG. The static code is included in early sequences of a series of encoded images so that when compressed the encoded information is in tact.

Brief reference will now be made to Figure 2, which depicts a decoder 20. Decoder 20 receives encoded images signal 24. The image signal 24 is split into a moving image signal 26. Edge diffraction then occurs. Edge detector 27 detects edges in moving

images. Edge detector 28 detects edges in static images. Detected edge signals 29 and 30 are subtracted one from another at subtractor 31 and a static edge is decoded at static edge decoder 32. Moving edges are decoded directly from a signal presented by moving edge detector 27 to the moving edge decoder 33. Static edge decoded signals 34 and moving edge decoded signals 35 are added at 36 to provide an electronic watermark signal which indicates for example, the origin of a signal or the owner of copyright in an image sequence or piece of video footage.

The invention may be used to encode information onto all forms of recording media. These may include videotape, video disc, compact disc (CD or DVD), or any other form of video storage medium. Similarly the invention may be incorporated into video broadcasting systems, video editing equipment, video monitoring equipment, televisions, computers or any other piece of electronic equipment used to produce or view video images, including a video cassette recorder and set-top box.

The invention has been described, by way of example only, and it will be understood that variation may be made to the embodiments described without departing from the scope of the invention.

CLAIMS

1. Apparatus for encoding information into a moving image sequence, comprising: means for identifying a region in an image in the sequence, means for determining whether the said region is a moving or static region and means for inserting a code into at least said moving image region.

2. Apparatus for decoding information from an encoded moving image sequence, comprising: means for identifying a region in an image in the sequence, means for determining whether the said region is a moving or static region and means for recovering code from at least said moving image region.

3. Apparatus according to claim 1 or 2 wherein means is provided to identify moving and static edges and signals representative of said moving and static image regions are sent via first and second channels so that code is inserted into, or recovered from, either or both of said channels.

4. Apparatus according to claim 1, or claim 3 when dependant on claim 1, wherein a first code is inserted into signals in a first channel and a second code is inserted into signals in said second channel.

5. Apparatus according to claim 4 wherein the first and second codes are identical.

6. Apparatus according to claim 4 wherein the first and second codes are different.

7. Apparatus according to any claim 1 wherein code is inserted into a moving image region of a moving image sequence in such a way that the code is resistant to image compression.

8. Apparatus according to claim 1 wherein code is inserted into a region of a moving image so that the code is resistant to low pass filtering.

9. Apparatus according to claims 1, 7 or 8 wherein the code is inserted into boundaries between regions of different luminance, chrominance or contrast.

10. Apparatus substantially as herein described and with reference to the Figures.

11. Apparatus according to any of claims 1 to 10 which is included in video recording, video broadcasting, video viewing equipment; or a television receiver or a set-top box.

12. A method of encoding information into, or decoding information from, a moving image sequence using the apparatus of claims 1 to 10.

13. A method of encoding information into a sequence of images; the sequence of images comprising: a first image and a subsequent image, the method comprising the steps of: locating an edge in the first image, locating a corresponding edge in the subsequent image, comparing relative positions of the corresponding edges in said first and second images, thereby identifying either a relatively static edge or two relatively moving edges; inserting a first code into said moving edge and inserting a second code into said static edge.

14. A medium storing a video or cinematographic image or sequence of images thereon, characterised in that a code has been inserted into selective portions of said images, according to the method of claim 12, when dependant on claims 1 or claims 4 to 9, or claim 13.

ABSTRACT

An apparatus for, and method of, encoding information into and decoding information from, a sequence of moving images, such as video images.

It is known to insert codes into images for purposes of identifying the owner of the images. However, existing schemes have suffered from the disadvantage that certain data compression techniques have removed or degraded the code so that the code cannot be later recognised.

The present invention solves the problem by identifying moving and static portions of an image in an image sequence and providing two separate channels, one for the moving portion of an image and the other for a static portion of an image. One or more codes are then inserted into both moving and static image channels, so that moving image sequences including the code are, preserved even after image compression or low pass filtering.

(Figure 1 accompanies the abstract)

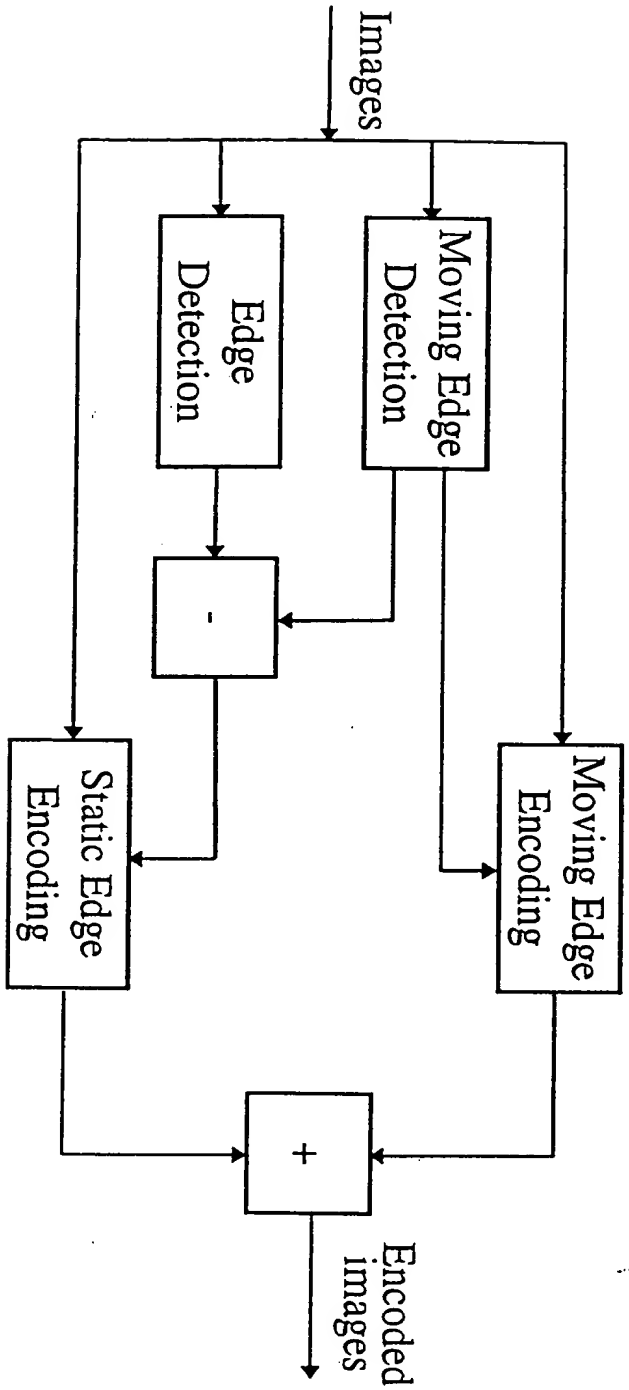

Figure 1: Encoder

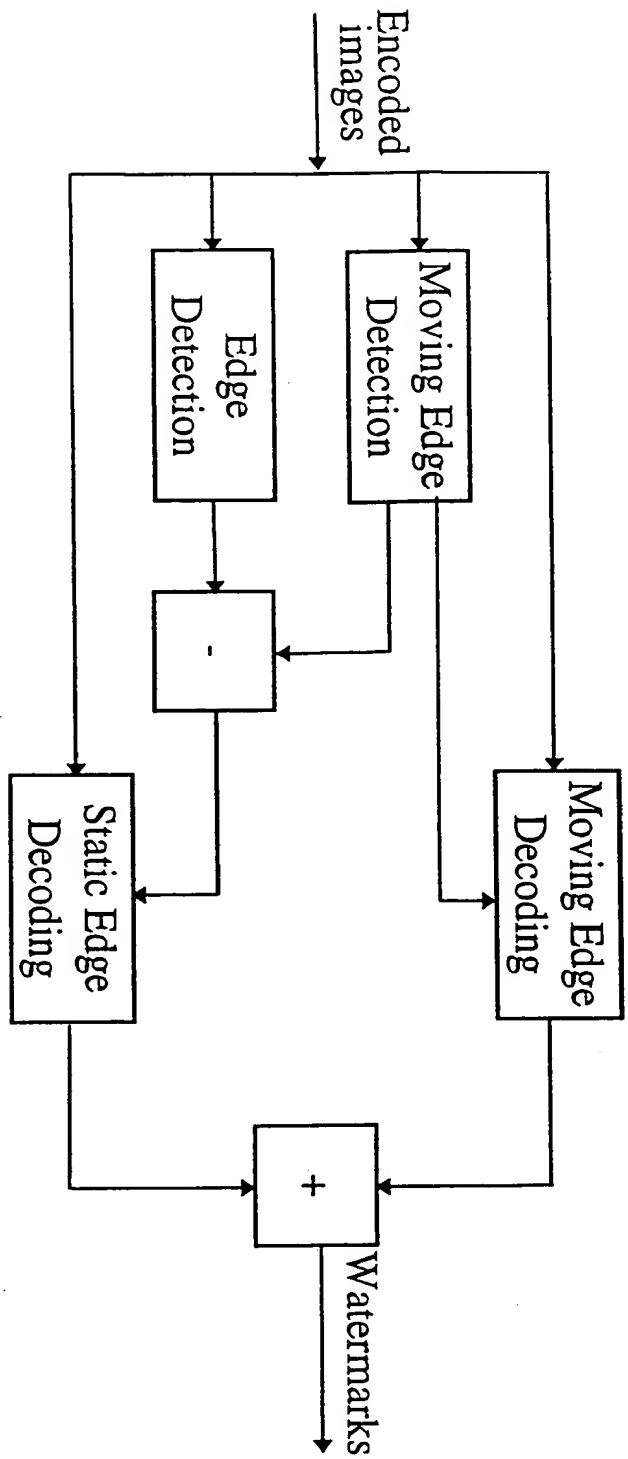

Figure 2: Decoder

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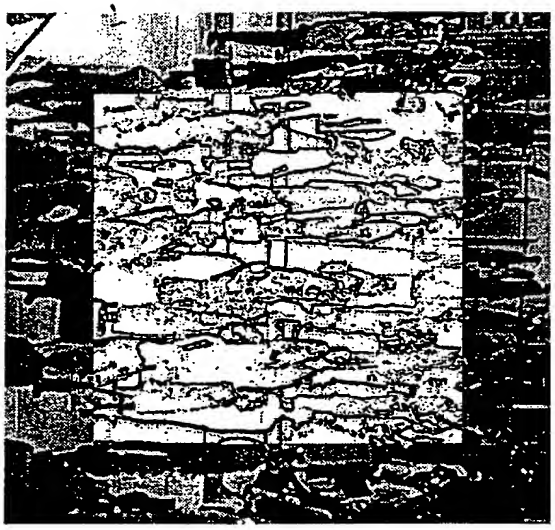

Figure 3: Edge image

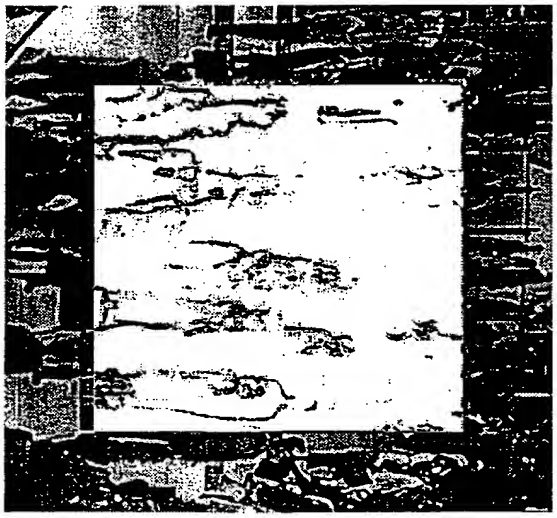

Figure 4: Moving edge image

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